SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

No. 1747.—Vol. XXXIX. LONDON, SATURDAY, FEBRUARY 13, 1869. {STAMPED .. SIXPENCE. UNSTAMPED, FIVEPENCE.

The Royal School of Mines, Jermyn Street.

Mr. WARINGTON SMYTH'S LECTURES.

[FROM NOTES BY OUR OWN REPORTER.]

Lecture XXVI.—We have seen in the last lecture that a great deal of the work preparatory to actually getting the mineral sought is horizontal, and to which the name of levels is given, but that these may be variously grouped, not only according to the size, but the purpose for which they are intended; and, further, whilst some are driven great lengths to drain a whole district, others are purely "dead work" to open out the mine, and to reach the deposits intended to be removed. I mentioned amongst the grander and larger drainage adits that intended to unwater the Clausthal district of the Hartz, as one remarkable for the speed with which it was completed, the work being carried on at a number of points by means of sinking shafts to the intended level, and then driving out right and left towards each other. There are others equally gigantic, which are even more remarkable from the circumstances under which they are carried out. One of these is the Francis adit, so called after the Emperor Francis Joseph, at Schemnitz, in Hungary, and carried out by the Austrian Government, where the drift goes under high mountains, through which it would be impracticable to put down ventilating shafts, and thus the least distance from shaft to shaft is 1¾ miles. There is nothing like this except the great tunnel of Mont Cenis, which I have already described. The Oscar level for draining the Persberg Mines, in Sweden, is also a remarkable work; and in Saxony there is an adit of this kind 20 miles in length, which unwaters almost the deepest depths attained in the deep mines of Freisberg. Drainage levels of this kind have done good service also in this country. The great county adit in Cornwall, for instance, is a work which, although it nowhere passes underground to any great distance, is about 40 miles in length, draining the rich mining districts of Redruth and Gwennap to a depth of from 30 to 40 fms., and carrying away a good amount of water which would otherwise go into the mines, and have to be pumped out. The usefulness of these works depends much upon the geological nature of a district. For instance, in some limestones districts an adit drainage would be of no use, but in others just the reverse. In Derbyshire the shallow workings make no water whatever, but when the mines reach greater depths the quantity of water that comes in is so enormous that no amount of machinery would be able to keep it under, and in this case the driving of an adit level (or "sough," as it is called in that country) is the only way of dealing with the difficulty. These undertakings, when carried through a whole district, are effected by each mine proprietor agreeing to pay a proportionate share of the cost. In this country it is difficult to make arrangements of this kind, as there are always so many different interests to deal with, and men estimate their chances of profit so differently; and in old countries, such as Cornwall, many of the richer mines have reached to so great depths that adit drainage could not benefit them. In the North of England, however, a large proprietor, Mr. Beaumont, M.P., being hampered by no difficulties of this kind, has carried out a drainage adit six miles in length, by which his deeper lead mines at the upper end of the Allendale Valley are unwatered.

When we look at the plan of a mine or colliery, we see that there is a great deal of what is called dead or narrow work; and it must be obvious that its cost must be greater in proportion than that of getting out larger masses in the workings. It is, therefore, a question whether a considerable part of this dead work cannot be dispensed with; and it sometimes happens that in making progress in this way a piece of ore is met with which will pay the cost without the level, but not with it. And so, again, in a coal mine there are certain methods of working in which these narrow drifts are done away with almost entirely by carrying forward a broad, wide base of working. The same thing may be done on a lode which the miners may thus take away bodily before them. In the case of coal, however, there will be a difficulty as to the roof, which it will be impossible to sustain of such large dimensions, and the roadway must, therefore, be supported by temporary timbering, and then carried between two lines of pack walling, all the rest being allowed to fall in up to the face of the work. If a lode be a small one, say 6 in. in width, the miner must carry it with him—that is, make the level large enough to take in the lode too, or it may be carried on the one side or the other according to circumstances. If the lode increases in size, the working will probably have to be varied. Again the lode will be sometimes so oblique that it will not be advisable to use the workings in it as a roadway at all, but to carry the thoroughfare alongside. In cases of this sort, where there is what is called stickings—that is, a thin, well-defined division between the lode and the country—the lode may be wedged down, and at half the cost which would have to be incurred if they had not the advantage of that slight physical division. When, however, we come to the larger lodes we may be put to considerable doubt as to what are the best means of dealing with the level, and where it may best be placed. It cannot be carried the whole width, as it would be impossible to sustain the roof, and there may, besides, be special circumstances adverse to such an attempt, which the amount of timber alone that it would require, would render it too expensive. We must, therefore, examine the nature of the lode and the ground. Supposing the lode to be of loose material, while the walls are hard and expensive to work, then they must cut away half the width, or some other such proportion as may suit the case, and put in props, working the remainder of the lode from the level thus made. [The lecturer illustrated this problem with a drawing, as, indeed, he did all the other supposed cases put before the students.] When the lode is composed of material through which galena or tinstuff is disseminated, and it is, therefore, desirable to remove the whole, the level may be driven in the ground at the side on either the footwall or the hanging wall, the choice of which must depend upon the nature of the ground. It is obvious that the hanging wall will be likely to fall in when the greater part of the lode below is taken away, so that what steps should be taken to secure the permanence of the level will depend on whether or not it is necessary for it to remain as a thoroughfare. In driving the level entirely in the country at the side there is the difficulty that nothing is known of the lode, and, therefore, it is necessary to make frequent cross-cuts. In the Phœnix Mine, near Liskeard, it is from 12 to 16 ft. wide. On each side was hard granite, but it was found to be less difficult and expensive to drive in the country than in the lode, which was very much harder. So that if the lode be either very loose or very hard, it will often be found the best to drive the level in the country by its side. In the Phœnix lode they made cross-cuts every 20 fathoms to see whether it become more or less orey; and it will be seen that there is a risk of losing a valuable piece of ground unless cross-cuts are frequently made. When the lodes get beyond a certain size they are worked in various ways, as in some cases by fire-setting, and occasionally vast spaces are opened out, when the hanging wall comes down in such immense blocks as would break any timber it would be possible to put in. In such cases the only means of obtaining security for the thoroughfares is to place the levels at some distance from the lode.

There is another aspect in which we must look at metalliferous mines. It is frequently the case that the miners, when following a lode, lose indications of its presence, and are left in doubt whether they are driving in the right direction—in fact, whether they are in the lode or not. The vein may be so nipped in size as to be reduced to a mere joint, or even become undistinguishable from other joints which may occur in the country. In these cases a great many blunders are often made. Sometimes they come to the conclusion that they have missed the lode, and then arises the question how to get back to it; but there are so many changes in the lodes themselves that the problem may meet with various solutions. If we look at the map of the Carn Brea (exhibited on the wall) we shall find that the workings show extreme divergence from right lines, partly because the lodes themselves are extremely irregular, and so when one is lost the miners scarcely know which way to go in search of it; but, as a matter of fact, the men generally diverge from the right line with the softer ground, not purposely, but, perhaps, naturally, as it works easier; and then, when the agent comes to examine the forebreast with his compasses, and dials it, he finds that it is not the regular lode, and the mischief may be remedied by returning to the proper direction. The same sort of thing occurs with the large lode of Schemnitz, and in the Great Laxey Mines of the Isle of Man (two instances already noticed in Lecture III.), where lodes, varying in the first case from 30 feet to 60 feet, and in the latter 8 feet to 10 feet, dwindled to an inch or two, and disappeared altogether. The levels, however, were perseveringly driven in the same direction, and at last the lodes reappeared of their former thickness and value. Sometimes in large lodes one course of ore dies out, and another begins at a short distance off, which becomes the main course of ore, and occasionally there will be a succession of these "slicers," as the miners call them, one above another. This is not due to dislocation, as it generally happens that one slicer overlaps the other. Cases in which dislocation has occurred present frequent problems of more or less difficulty to the miner, in which the engineer should be careful to see that no mistake is made, as the miners, if left to themselves, are very apt to drive the wrong way.

The next point of our subject will have reference to those levels in which some sort of protection is requisite to prevent the closing in of the sides or the breaking in of the roof, involving not only the arrangements necessary to preserve the main thoroughfares, but to screen the men from danger as they advance. The first question will naturally be what material is to be used, whether timber or masonry, including, of course, brickwork. Timber is by far the most frequently employed for its greater convenience, the greater rapidity with which it can be brought into play, and its more considerable cheapness in levels for temporary purposes. The timber employed in mines costs an enormous sum annually, and economy, therefore, is of the highest moment. It is not only the first cost, which is often considerable, but in some mines timber rots so rapidly that it has to be replaced at a cost of thousands of pounds in a year, and in some cases even in a less time. In considering the various qualities of timber, it must be remembered that three different kinds of power is requisite—first, its power to resist fracture when the extremities alone can be supported, as in the case of transverse beams; secondly, the power of resisting compression; and, thirdly, of extension. Besides these, resistance to decay and price must also be taken into account. In estimating the strength of timber it must be remembered that it is applied in very different ways—sometimes as single props as in the long wall system; at other times, when it has to resist pressure, transversely to the fibre, and at others to resist a strain both ways, having a tendency to pull the fibre asunder, as in the case of pump-rods. One kind of timber then, it is obvious, is best suited to a particular kind of work, and another to another. With regard to cost, it is impossible to say anything generally. In the Hartz, where the mines are in the midst of pine forests, timber is obtained at an easy rate, and of an admirable kind for the purpose. In Cornwall, where there is but little timber, that defect is supplied by a good seaboard; and Baltic timber, which stands excellently, is obtained at a moderate cost. In other countries, as in Spain, for instance, it has to be conveyed considerable distances at a great cost. Generally speaking, districts which have a seaboard enjoy great advantages. Thus, in Cornwall we see magnificent timber from Norway and other countries, and indeed from the ends of the world, as a great deal of most excellent quality is brought from Vancouver's Island. The different kinds of FIRS and PINES produce timber which is cheap, light, and straight, many sorts having great durability besides. The Larch (*pinus larix*) has the advantage of resisting alternations of damp and dryness, and is less liable to rot than most other woods of the PINE genus. It also resists very well the heavy weights which have to be supported in timbering levels. Another excellent wood is that of the Spruce or Norwegian Fir (*abies excelsa*). The Scotch Fir (*pinus silvestris*) ought to be called Baltic timber, as the wood known by that name comes from Memel and Riga, while that which is grown in Scotland is very inferior, and of quite a brittle character compared with the other. The Silver Fir (*pinus abies*) is a beautiful tree, but does not furnish so good a wood as others of the family; but where readily obtainable is frequently used, as in the Hartz. OAK is also largely employed, and possesses in an eminent degree the qualities of strength and durability, but it is too expensive, and especially so if the levels are large. In thin seams, where it can be employed as props in short pieces, without much cutting and shaping, it is very useful, and lasts ten to one better than the *coniferæ*. Larch holds its own very well against Oak, but the others are not to be compared in durability. BEECH and BIRCH are employed in some countries, but they are more brittle than the *coniferæ*. In the South of Europe SPANISH CHESTNUT is much used, and lasts remarkably well. It is also employed a good deal in America. In some parts of Italy, and in the South of Europe, and in Brazil, the ACACIA is used, and is well spoken of as resisting the alternations of wetness and dryness. These are preliminary matters, but when the engineer has high temperatures to deal with, or a want of ventilation, the quality and choice of the timber are of great importance. Good ventilation will be found to keep down the timber bill to a greater degree than inexperienced persons would suppose.

Lecture XXVII.—We have examined a few of the circumstances under which levels are horizontally driven, sometimes in one part of a large lode and sometimes in another; and cases in which it is advisable to carry them through the country at the side, occasionally for the more convenient working of the deposit, or for the purpose of securing a permanent thoroughfare; all of which showed how necessary it is for the manager to have his eyes open in fixing upon the position the levels should be placed. We have also examined some of the means used to secure the safety of the men against the falling in of roof, and breaking in of the sides, and other dangers of that kind, which would be hindrances to the economical conveyance of the mineral, and keeping open of the thoroughfares of the mine, and we will now devote half-an-hour to the consideration of the circumstances under which timber is usually employed. It must strike us at the outset that there must be in mining many circumstances in which, while pushing our way through the depths of the earth, difficulties would arise. Thus we might have to drive through a mass of quicksand or soft-yielding watery granite, in either of which great difficulty would be experienced, and which would require special treatment. First of all, a word or two on the use of single props or pieces of wood. There is in this country an enormous amount of life lost every year, in consequence of the breaking in of the roofs and sides of mining excavations. How can this be obviated? This great loss of life would appear to some persons easy to prevent, but it is in point of fact impossible to lay down any absolute rules of prevention, in consequence of the great number of circumstances under which falls of roof take place. If we take a piece of roof supported by simple props we shall find that they are required under an amazing variety of conditions. If the roof be free from fissures, the number of props may be comparatively few. In some collieries where there are a great number of fossil trees, peculiar dangers are incurred. These antediluvian sigillaria are often met with in an upright position, or at right angles to the plane of the coal seams, varying from half-a-foot in diameter to much larger dimensions, and weighing from 3 to 4 cwts. to a ton. In driving or removing the material from beneath them, they are very apt to slip out, without any notice, on the men beneath. This is easily accounted for, as the lower end of a trunk of a tree is generally the largest, and as these fossil trees frequently have a distinct, although, perhaps, very thin, plate of slimy clay around their circumference, and between themselves and the mass of coal in which they are embedded. When, therefore, a ring of this sort is observed it is very important that a vertical prop should be placed beneath it at once, without reference to any other consideration. Again, if we see that a roof is full of joints, it will be necessary that it should be supported, and, perhaps, not only by props, but by head pieces, or caps, at the top of each or extending over several. In cases of this kind, every careful manager will look strictly to the goodness of the timber used, and to its being properly placed. This will probably not be done if left to the men themselves, for it is astonishing how colliers will work on with their lives in jeopardy, every stroke increasing their danger, rather than devote a little time to setting timber—indeed, a great number of accidents are due to the carelessness of the men themselves, and it ought to be a rule in every colliery that a proper person should have the duty devolved on him of setting timber. In some collieries the deputy overman is deputed to go round and set the timber wherever it may be necessary. This may be advisable, not always because the men cannot be trusted, but because many have not quickness of eye or sufficient judgment to detect the first indications of danger. No person, therefore, ought to be appointed as timberman who has not had experience, and who is not conversant with the various dangers which make the use of timbering indispensable. When single props are put in they require frequent inspection, as if the pressure from above be great they will, as it were, be pressed into the roof, which will begin to break down; and, therefore, it will be necessary to enlarge the bearing power, by putting in head plates, which are usually pieces of timber, about 2 ft. long, and 4 or 5 inches in thickness. It is often found that these top plates are squeezed into all manner of shapes, and the prop itself so split as to require renewing. In long wall working the men are placed along a large face of coal, and they are then protected by props placed in alternate rows thus:—o o o o o o o. As they advance a fresh row of props is set up, and the hindermost row removed, the roof being allowed to fall in behind them, unless some preparation is made to receive it by packing up the rubbish. Recovering these back props is often a matter of difficulty; sometimes a smart blow at the bottom will displace them, at others a chain is attached to the bottom of the prop, at which several men can pull at once, or a common jack is attached to the chain. This is an operation to be exercised with caution, but the men know pretty well how far they may venture. The miners, however, think it a point of honour to recover the whole of the timber as they advance, and as they are besides paid extra so much a prop for all they get out, or a deduction from wages is made for all that are lost, they are often so extremely daring as to go where the roof is literally falling about them. Sometimes the heel of the prop is so firmly fixed that they have to dig around it. Thirty years ago cast-iron props were tried in some mines, but did not seem to give general satisfaction. They were made in two parts, keyed together, and the key being removed they at once came asunder, and were easily removed. It has been suggested that the placing of props should be made compulsory by Act of Parliament—that is to say, the workmen should not go more than a certain number of feet without a prop being put up, but I cannot help thinking that a Procrustean measure of this kind, which would fit some places, and not fit others, would be mischievous. In some places it will often be found that the work may be carried several yards in width with perfect safety, while in others it cannot be taken as many feet. Sometimes it may be that any props, however numerous, are insufficient to keep up the ground, and then a plan is generally adopted which in the North of England is called "nogs" or "chocks." This consists of pieces of wood, 3 or 4 ft. in length, built up until they become a pillar of timber, and these are placed at short intervals, and are capable of bearing up an enormous pressure. Indeed, it is by these "chocks" only that long wall working is possible at all in some collieries. Another class of timber is that used where the material is undercut or holed, which is the case in many of our English collieries. The seams can be undercut in some cases to a considerable extent, and then the mass above can be brought down with great advantage. If there should be a distinct parting between the roof and the coal, it is very liable to come down, and props or sprags should be put in, and when the men have to hole in for 5 or 6 ft. the superincumbent mass ought to be properly and abundantly supported with sprags, just as regular props are in wide working. If there be no division of the coal at the roof, and the pressure is not great, the sprags are often put as much as 6 or 8 ft. asunder. Sometimes there is a thrust upon the face of the coal, and sprags have then to be placed in the front to prevent the coal from falling forward before the holing is completed. A similar precaution is necessary when the coal is to be brought down by a charge of powder or wedges, as the men are never safe from sudden falls; and no sprags or props should be removed until everything is ready for the actual taking down of the coal. These are the cases in which single props are in this country most largely used. In metalliferous mines, if the lodes are jointy or intersect one another, and are liable to let large pieces down, then single props, whether vertical or oblique, are used.

The next class of circumstances which require timber is where the two sides of the excavation as well as the roof have to be protected. This is specially requisite in metalliferous mines, and for this purpose what are called "stull pieces" are used. These are pieces of timber placed on the head of the prop, which, being struck with a heavy hammer, is forced into a straight line, and upon these lining timber or strong planks are placed, on which the miners pile up fragments of stones and rubbish so as to protect the roof. [Mr. Smyth here exhibited a number of models illustrative of this kind of operation.] If it is wished to get a large bearing surface, it is usual to put in head boards, and if the rock be jointy a great deal of this work may be required. Passing from these simpler cases, we must next consider not so much the pressure from above, which hitherto we have chiefly regarded, but that which has to be met from directions lateral or transverse. This requires what may be called a frame work within the level, or, as it is termed in Cornwall, a "durnz," or in Germany a "thürstock" or doorway. Supposing there is a tolerable strong floor, and the level is required to be 3 or 4 ft. in width, and 6 or 7 ft. in height, care must be taken, no matter what the inclination of the lode, to place the leg pieces symmetrically, and it may be necessary to place cross pieces at the bottom as well as at the top. If the pressure is great from above, particular care must be taken as to the joints of the timbering, several ingenious examples of which, particularly that called the Cornish cap, were drawn on the board by the lecturer. In the collieries and iron mines in the North of England, where round timber is usually employed, the cutting to receive the cap if too small often splits or injures the uprights. [Several models of this round timbering were exhibited.] When timbering is of the largest size, the difficulties attending its construction are greatly increased. Thus, if the foundation be bad, it may be necessary to put in a sole piece or sill of unusual thickness and strength. At the Botallack Mine, for instance, which is carried for 160 fms. below the sea level, it is necessary to keep open the thoroughfares to the deeper portions of the mines by immense stemples, supported by struts. But, perhaps, the most remarkable timbering of mines in Europe is that to be seen at the Devon Great Consols, where timbers from 20 ft. to 35 ft. in length, and of proportionate thickness, are used. At the St. John del Rey Mine, in Brazil, the walls are supported by innumerable timbers of large size, some of the struts being built, as it were, of several pieces. Near the Wheal Anna Maria, in the Great Devon Consols Mines, there is a remarkably strong piece of timbering of unusual shape. There is no head piece, and the side pieces come together at the top, forming with the sole piece a triangle. The side pieces are 18 ft. long by 15 in. square, and it is lined with planks over the whole. The space between the side pieces and the ground above is carefully filled in with attle, so as to equalise the pressure. The structure is further strengthened by struts across the upper part of the triangle. Instances of this kind, although unfrequent, show to the intelligent mining captain or manager what may be done to meet any special circumstances with which he may have to deal.

Lecture XXVIII.—I have already indicated (said Mr. SMYTH) that one of the greatest difficulties with respect to timbering is its preservation from dry-rot, which, under some circumstances, may be so rapidly destructive that the timber may require to be replaced as often or oftener than six months. It then may be a question whether, if a level is required to be kept open as a thoroughfare, the timber should not be replaced by stonework or brickwork; or if the level be only intended for temporary purposes, it should be done with as soon possible, and allowed to fall in. It is possible in some cases by introducing better ventilation, or by causing water to trickle over the woodwork, that it may be made to last longer than otherwise. In some districts, if they have tolerably strong shales, for example, or rocks of a stronger description, although the timber may be put in very well originally, it will often be found that the cap-pieces begin to go first. They will begin to curve downwards, by reason of the pressure from above, and ultimately break asunder in the midst, which it may be of the utmost importance to prevent, by putting in extra timber, and thus to try and stop the pressure from doing considerable injury, as if one cap-piece goes, the others are pretty sure to follow. Suppose we have three cap-pieces beginning to fail in this way, then a long piece may be put in to support the first and third, while the middle cap-piece is replaced, taking great care by propping not to let down the upper ground, or serious results may take place. Sometimes longitudinal pieces are put in to save the falling durnzes, as well as to enable them to put in new timber, and when the ground is of a yielding character, it may be necessary to leave in the additional work of this kind. It is true that a serious objection arises to putting in so much timber—that it greatly reduces the area of the level; but in old adits, which have been open for a long time, and subjected to continual pressure, this is unavoidable. In some mines, when the pressure is of an extremely irregular character, the cost of replacing timber amounts to many thousands a year. I saw a mine of this kind a few months ago, in which the timbers were of large size—13 inches by 8 inches thick—which were, nevertheless, singularly bent and broken by the thrust, the thickness over the uprights being reduced from 13 inches to 9 inches by the pressure, and in some places the whole of the fibres were twisted and broken off close to the caps. It is true the timber, having been creosoted, had lasted for three years, which was a long time for that mine. When the presence of dry-rot is observed in a piece of timbering, it is wise to have it removed at once out of the mine, and replaced by sound timber, because the spoor or fungus in some way is borne on the air, and spreads the mischief widely and rapidly. The nose is a good detective, as the peculiar odour produced by dry-rot is recognisable at its earliest stages; and the importance of vigilance cannot be too highly enforced, as in most cases, and particularly in shafts, if not combated in time, the safety of the whole workings will be endangered. I have already mentioned the difficulties which often intervene at the first starting of these levels, in putting in the first means of security, and that many have to be timbered up to within a small distance of the end, so that they cannot, with propriety, advance a single foot, or even a few inches, beyond the last set. This is particularly noticeable in the soft material called plum granite, or in driving through old workings, when this has frequently to take place. It is sometimes the case that in driving a level the men will come into ground where the stull-pieces give way, and all above is ready to come down as fast as the mass below is removed, and there may be 60 feet to 100 feet over them of such material. I need hardly say that this is a state of things which requires not only a great deal of care, but a great deal of experience and circumspection. I do not know a more remarkable case of this kind than that which has resulted in the apprehended loss of the famous salt mines of Wieliczka, in Poland, where, in consequence of driving a level towards dangerous ground, without sufficient precautions, the workings were exposed to the action of a torrent of water, and there is a risk of the entire destruction of the whole mine; and not only that, but as a large town stands upon the surface, it is not an unreasonable supposi-

tion that the falling in of such large excavations will also ruin the town. Neither will this comprise the whole loss, as a large population would be deprived of their employment, and the Austrian Government of a very large revenue derived from the salt. And this has been brought about simply in this manner. The excavations were sought to be extended by driving a cross-cut in the direction of the River Ischia, which is cut off from the mine by a bed of impervious clay, called "tegel." Beyond this is a series of tertiary sands and gravels, heavily charged with water from the river. The cross-cut, then, having passed through the tegel, came so near the sand that the water in considerable quantities flowed in through the joints of the rock; before anything was done it burst through in overwhelming quantities, drove the men out of the cross-cut, very quickly filled the lower workings, the River Ischia being, in fact, let in, and at the last accounts the water was still rising. The clay had hitherto been a sufficient protection, and the catastrophe is simply due to the miners driving too hastily through it into the watery beds. The lecturer made an explanatory drawing, of which the following is a copy:—

A,—Shaft. B,—Drift. C,—Clay, Tegel. D,—River sand and gravel.
E,—Where the water broke in.

It appears that the miners did keep a short bore-hole, about 6 feet in length, in advance; but knowing, as they did, of their proximity to such dangerous ground, it would have been more consistent with proper caution not to have continued the level at the full size, but to have driven a smaller one, with other smaller ones branching out at the sides, and bore-holes kept largely in advance. The process is well-known, and frequently practised in our colliery districts, where, as I have described in a previous lecture, they would, under similar circumstances, have not only have had a bore-hole in front, but flank bore-holes as well, for the purpose of feeling their way towards the point of danger, with plugs all ready prepared, in case of water being tapped, to cut it off. It then would be a question whether to go on at all, or whether to attempt to pump away the water without allowing it to run into the mine. In the Durham district a very similar case occurred not long since, where it being necessary to drive through a stratum of sand highly charged with water, it was approached in the cautious manner I have described, and then only so much was taken at a time as they were able to contend with, and eventually the danger was surmounted. Let us see, on the other hand, what has happened in this respect at Weilitzka. This large body of water having rushed in, soon began to affect the ground where the timber was placed. It was strong ground, but the salt in it being considerable, was soon dissolved and washed out, and the cross-cut and levels, into which the water had gained admission, soon came to ruin. They then attempted to erect dams, but they were drowned out before they could effect that, and the water found its way into the large workings.

When miners have to make way through loose, running, or watery ground of this kind, or through old workings, they have recourse to what is called "spilling." Some remarkable examples of this kind of work may be seen at the hematite mines of North Lancashire, in the neighbourhood of Ulverstone. The shaft is sunk in the solid ground, and at first the levels are protected by ordinary timbering, with cap pieces supported by uprights; but on getting into soft ground it was found necessary to call in the aid of "spilling." Pieces of strong board, pointed, and sometimes shod at the extremity, termed "laths" or "poles," are driven in at the top of the level at an upward angle of about 15° or 20° from the horizontal direction, and the weight gradually brings that down to something near a horizontal line, which forms the roof overhead. A row of timbers is then put in to receive it, and then beyond that another line of "spilling laths," and so on; the workmen being thus guarded, gradual progress is made even in the most difficult ground. A similar process has sometimes to be carried on at the side as well as the roof of the level, but the principle is the same, the angle at which the spilling laths are driven being somewhat less. Sometimes the system has to be carried out with the greatest exactness, a necessity resulting from having to drive through a soft material mixed with water, such as a running sand or a soft decomposed granite, in which much water is present. In these cases the spilling laths must fit to each other exactly, but with every precaution it sometimes will happen that a material of this kind runs in so fast that the level is what is called "lost." This was what happened at Weilitzka, but the influx of water was too great to allow of remedial measures.* The best thing to be done under such circumstances, ordinarily, is to "hark back," and then to drive into the ground at the side, which may be less difficult, and this sometimes has to be repeated over and over again. These methods are capable of great variation. Thus, in the case of East Wheal Rose, the whole of the ends of the levels had to be closed up, by what are called breasting boards. In the coal fields of Northern France and Belgium attempts have been made to drive levels through quicksands, but these attempts had been entire failures, in consequence of the material being in deposits of such large extent, and so saturated with water. In the commune of St. Vaast, a level for a colliery in a piece of ground of this nature was commenced in 1747, and in 1843 it had only advanced 1150 metres. Of course, it had not been worked at the whole of that time, but every now and then the attempts had been renewed, until, in 1844, M. Durieux, an eminent engineer, devised a plan which proved successful. Instead of attempting to remove the sand he pushed through it, and thereby prevented those ruinous runs which had followed all the preceding excavations. It was effected by driving the face and sole full of oak pickets, boxing in the sides of the level with driving laths. As much advance was made in this instance in a few months as it had taken years to effect previously. Difficulties of this sort are got over in making railway tunnels, by dealing with only a small portion of ground at once. One of the most remarkable cases of this kind in the world was that of the Thames Tunnel. The system of opening only a small space at once was the best that could be devised, for in all tunnelling it is found that there are dangers which can only be safely encountered by that method. It falls to the lot of miners frequently to have to open out larger spaces than usual, and the great secret of safety and success in heavy ground is to open out only a small portion at once. It is customary in such cases to drive a small shaft ahead through the ground, timbering it for safety; another drift is then driven at the top, with great caution if the ground be movable, and then other portions opened, and at length united. When the nature of the ground renders it impossible to open a large piece at once, the men work small spaces, with strong timbering around them, and so push forward. A careful attention to the details of these precautions is the only way to prevent accidents where the ground is in a crumbling condition, or rendered dangerous by the presence of a large quantity of water.

BORING BY MACHINERY IN AUSTRALIA.—The first public trial of Ford's Boring Machine took place in the Hustler's Reef Company's mine, in the presence of the committee. There were present—Mr. R. G. Ford, the inventor (railway department); Messrs. Joseph Millin, manager of the Hustler's Reef Company; Thos. Eyre, of the Catherine Reef Company; Joseph Harris, of the Argus Company; Talbot, Hawkey, and T. J. Connelly. We learn from the *Mining Record*, of Victoria, that the first start was not successful, owing to a piece of slate operated on being loose, and 20 minutes were occupied in setting for the first hole. The first hole was then bored, as follows:—10 in., 3½ minutes; 1 ft. 1½ in., 1½ minute—1 ft. 11½ in. in five minutes. The hole was sloping. Fifteen minutes elapsed in fixing for the second hole, and in it 6 in. were bored in one minute; but, owing to the borer being crooked, another had to be supplied, the supplying which took 7 minutes. The hole was then bored 2 ft. in 3 minutes 15 seconds, as follows:—6 in., 1 minute; 12 in., 1 minute 15 seconds; and 6 in., 1 minute. The third hole was bored nearly perpendicular, and was 2 feet 1 inch in depth, being done in 3 minutes 37 seconds. The fourth hole was in quartz, and there was some difficulty at first in getting the borer to take, as the face it had to work on was chipped and irregular. Eventually, however, the borer took, and did its work in good style, making the fire fly in spite of the water poured on it; 6 in. was bored in this hole in 1½ minute. The whole time occupied in boring this hole in quartz cannot be accurately stated, owing to a mistake; but the time almost beyond a doubt was 4 minutes 40 seconds for 2 ft. 2 in. The last hole put in was a perfect success. The machine was lowered, and the stone operated on slate and sandstone, and 2 ft. 6 in. done in 5 minutes 45 seconds, the machine rattling through its work in fine style. All present expressed themselves highly satisfied with the results of the day's experiments, and remarked that when the men would have about six weeks' practice with the machine it would be worked without the least difficulty, and in half the time these preparatory trials took. The degree of pressure was ascertained every quarter of an hour during the trial, and gave an average of 75 lbs. to the inch. The average time occupied in setting was 15 minutes, and in fixing drills 5 minutes. The stone worked was of average hardness, it being reckoned that it would cost 2*l.* per foot to bore by hand.

* At a subsequent lecture (that delivered on Thursday last) Mr. Smyth again referred to the Weilitzka disaster, which he said had now been shown by later intelligence to have been greatly exaggerated. So far from an underground river being let into the mine, as some accounts had represented, the quantity of water which came in at the first was so slight that the ordinary pumping-machinery of our more heavily-watered mines would have cleared it with the greatest ease. The fears entertained were, perhaps, not to be wondered at in miners unaccustomed to deal with water, and having at command none but little trumpery engines, calculated to raise only a few gallons per minute. Even at the worst, one of the large Cornish engines which he had been describing, with a 60 or an 80-in. cylinder, would have cleared out the superabundant water in a very short time. After all the alarming statements that have been put forth, it is satisfactory to find that the water in the mine is capable of being kept under by a pumping-engine of very moderate dimensions.

THE HAULAGE OF COAL.

The continually increasing demand for coal, and the necessity which exists for supplying it at the lowest possible price, in order to admit of successful competition being carried on, causes much interest to attach to all that relates to the practical details of colliery working. For the diffusion of a knowledge of such details the North of England Institute of Mining Engineers has ever used the most praiseworthy exertions, and the report now issued* is, without doubt, one of the most important contributions to mining literature which has yet been made. The committee have given their best attention to the tail-rope, the endless-chain, and to two forms of the endless-rope system, in use respectively in Nottinghamshire and at Wigan, as well as to an endless-chain system at use in South Wales. The question of the relative merits of the several kinds of haulage formed the subject of many animated discussions during the visit of the North of England Institute to Manchester in 1865, and the report now issued fully confirms the opinion generally expressed at that time—each system has its merits and its defects, and the peculiar circumstances of each individual colliery must be considered before it can be correctly determined which system of haulage it is most desirable to adopt. The acting members of the committee were—Messrs. WM. COCHRANE, G. B. FORSTER, JOHN DAGLISH, LINDSAY WOOD, and R. F. MATTHEWS; and these gentlemen express their appreciation of the valuable services rendered by their engineer, Mr. EMERSON BAINBRIDGE, by whom the report has been edited and revised. The amount of labour bestowed upon the investigation appears to have been enormous, no pains having been spared to procure every detail which could be in any way useful for permitting accurate conclusions to be arrived at.

In order to give a general idea of the extent to which the TAIL-ROPE SYSTEM can be applied in leading coals underground along an engine plane with numerous curves and branches, a description is given of the arrangement of wagon-way, and the method of working the tail-rope at North Hetton Colliery, which affords one of the best examples of the many applications of this system in the district. In the working of this and all other tail-rope planes, two ropes are necessary, which are called main and tail ropes—the former being used for drawing the set of full tubs outbye, and the latter for taking the empty set inbye. When the main rope is bringing the full set outbye, the tail-rope drum runs loosely upon the shaft, and by applying the brake the tail-rope is made to run steadily off the drum; when the tail-rope is taking the empty set inbye the main-rope drum is put out of gear, and the main-rope is drawn inbye behind the set. With regard to the duration of the ropes, it can scarcely be ascertained, as a rope is first a main and then a tail rope, and is afterwards used as a tail-rope on a lighter plane—the general duration of the rope is supposed to be from two to three years. The report also contains description of the engine-planes at the Londonderry Seaham Colliery, near Sunderland; at the Seaton Delaval, near Newcastle-on-Tyne; at the Harraton Colliery, near Durham; and at the Murton Colliery, ample details with regard to each being given.

The tail-rope system is chiefly employed in Northumberland and Durham, where they have had many years experince with it, and brought it to a high degree of perfection; it is applicable to almost any condition of wagon-way, curves, irregularity of gradient, and the existence of numerous stations and branches forming no obstacle to its effective working. As to the general economy of the tail-rope system, it is stated that, owing to the high speed at which the sets of tubs are moved, the power required is often very great. The average power exerted in bringing out a full set by this system, on the planes experimented upon, varies from 86 to 149-horse power. The first cost of the engines, drums, and boilers necessary to produce this power varies from 849*l.* at Seaham Colliery, to 1410*l.* at Seaton Delaval. A large number of branches can be worked by the tail-rope system with almost as little annual expenditure, except in the item of labour, as the same length of road without any branches, since the power required is about the same, the number of tubs not greatly increased, and the wear and tear of ropes is not much more with branches than without, provided an equal quantity of coal be conveyed. The tail-rope and endless-chain systems differ very materially in regard to the number of tubs used, for with the latter the branches worked are generally continually going, and an increased quantity of tubs is required in proportion to the length of plane at work; yet when the tubs are placed at a considerable distance apart on the main road, without branches fewer tubs are required with the endless-chain than with the tail-rope system. It appears that the annual cost of leading coals on tail-rope planes is considerably in excess of the cost of endless chain roads; and when the wear of the ropes, the renewal of the sheaves and rollers, the occasional heavy damage done by the tubs getting off the way, and the heavy consumption of coal, owing to the horse-power exerted, are considered, the greater economy of the endless-chain system, which is affected in a very much less degree by the above items, will be understood.

In regard to the item of labour, when several branches are worked, the total cost of labour in leading coals by the tail-rope is about the same as by the endless-chain, although, as a rule, branches can be worked by the tail-rope system with much less labour than by any other system. As the first cost of the arrangements for the endless-chain system would probably be much more than for the tail-rope, owing to the large number of tubs which would be required, and the heavy expense of the chain, numerous pulleys, and a double line of rails, the tail-rope system would, perhaps, be preferable. On the other hand, the low cost of maintaining tubs and chains in working the endless-chain, and the cost of rollers and motive-power for the tail-rope, should be borne in mind; and, as regards the comparative capability of the two systems for conveying a large quantity of coals, it should be noted that whilst at the North Hetton Colliery about 520 tons per day is the utmost that could be led by the tail-rope, supposing the branches were yielding each the same number of sets, the endless-chain, under similar circumstances, could bring out more than double this quantity. The tail-rope system can be compared much better with the endless-chain than with the two endless-rope systems, which are only applicable under certain conditions of wagon way, whilst both the tail-rope and endless-chain systems can be applied under almost any circumstances. The chief defects of the tail-rope system, as compared with the endless chain, are—the heavy cost of the engine and drums; the necessity to cut long stone drifts on meeting large troubles, in order to make an easy gradient; the wear and tear of ropes; the heavy expenses of an accident on the engine-plane; the large amount of power required to overcome the friction of the sheaves and rollers upon which the ropes are carried. The item of labour composes from one-third to one-half of the total cost, and, as it occupies such a prominent place in the cost of leading coals, it is the cost of expense which should chiefly be considered in judging of the relative economy of the different systems of underground haulage. With this in view, the tail-rope has certainly an advantage over every other system, when the plane to be worked has numerous branches, and when the gradient of the wagon-way and branches is either level or undulating.

The experiments on the ENDLESS-CHAIN SYSTEM were all made at the collieries at Burnley, under the management of Mr. W. Washington. Though the endless-chain system has been in operation at Burnley and other parts of Lancashire for many years, it has until lately been very little known in the North of England. Like the tail-rope, the endless-chain system is adaptable to every condition of wagon-way, although in several respects it differs from it. As a general principle, it may be stated that when the two ends of an undulating plane are at the same level, the power required to work such a plane will be very little more than if the plane were perfectly level. A heavy gradient can be worked safely and efficiently. Since the chain will only work safely in a straight line, or, at the most, round a slight curve, every sharp curve upon the plane necessitates the erection of two pulleys in order to direct the chain to another curve, and requires the attention of a man or boy. This system is extensively followed on the surface at Burnley, and the district being very hilly, it is found economical. The slow speed at which the tubs are conveyed does not require a very carefully-laid wagon-way; they generally lay the way by only making embankments or erecting gearing when a stream or deep defile has to be passed over. In working a straight main-way (that is, with no branches) by the endless-chain the driving power is generally placed at the higher end of the ginney-road. The only wheels requisite for working the chain are the driving wheel at one end and a tail or return sheave at the other end of the plane. Between these two points the chain rests upon the full and empty tubs, the distance between the tubs being from 10 to 30 yards, and the speed from one to three miles an hour. The method invariably adopted at Burnley in order to get friction sufficient on the chain to prevent it slipping round the driving wheel is by passing it two and a-half times round the wheel; at Towneley Colliery it is passed four and a-half times round. When there is a curve in a single-chain road either the same chain is taken round the curve by two wheels on different shafts, arranged like the self-acting curves on the surface, or there are two pulleys on the same shaft, on which there are different endless-chains. If there be no branch way from the curve, the former method is usuall adopted, and the road is so formed that the tubs will leave one chain, and pass round the curve without any assistance; but as this cannot be depended upon, attention is always necessary at a curve. As far as hitherto proved, it may be laid down as a rule in the working of the endless-chain system that all curves underground require labour, and thus it is generally desirable to have a branch or branches from the curve, or to pass the tubs round by the self-acting method described, which could be managed by a boy at 1s. per day.

Comparing the cost of leading at Barclay Hills with the Hapton Valley and Rowley underground plane, it may be seen that a length of way and the direction of gradient do not affect the cost of leading nearly so much as a number of stations on a ginney-road, which not only increases the labour, but by their necessary gearing consume a great percentage of the power. In the remarks upon the tail-rope system the case of North Hetton Colliery was taken to show the comparative economy of labour of the endless-chain and tail-rope, under the North Hetton conditions of wagon-way. It is, probably, just under these conditions (the working of a number of branches) that the cost of labour becomes about equal in the two systems, the cost being less with the endless-chain when few branches are worked. On a main-road, without branches, the labour with the endless-chain is much less; thus, at Seaton Delaval the cost per day is 20s. 6d., whilst at Rowley surface plane it is 6s. 7d., and at Hapton Valley only 5s. 9d., about the same quantity of coal being led along each of the planes. The coupling of the tubs being avoided, a brakesman, rapper lad, runrider, and drum boy being unnecessary, and the self-acting nature of the termini of the ginney-roads, all tend to reduce the cost of labour; and a considerable item of economy consists in the constant working of the chain, causing the hands attending the ginney-road to be nearly always kept at full work. The cost of maintaining the planes worked by the endless-chain is very small. The long duration of the chain, the regular speed of the engine, and the slow motion of the chain on the ginney-roads, which, escaping the accidents common to the quick speed of the tail-rope system, economises rails and tubs, cause the cost to be less than that of any other system. The only defects of any note in the endless-chain system are that every branch or connection between a branch and the main ginney-road requires the attention of a man or boy; and that the first cost of wagon-way is greater than when tail-ropes are used, owing to the great weight of chain and a double way being requisite. The endless-chain is found of great service in a hilly district, where it can be used, as in Lancashire, on the surface, instead of an ordinary railway; and at Burnley, where the chain roads are seen traversing the country in all directions, the economy of its adoption is very apparent.

The ENDLESS-ROPE SYSTEM (No. 1), in use at Shireoaks Colliery, California Pit, Newsham Colliery, &c., is closely allied to the tail-rope, but has hitherto been adopted in the working of underground planes only to a limited extent. At Shireoaks a double way is used, and the rope moves on rollers in the middle of the way, the set of tubs being taken in on one way and brought out on the other. Motion is given to the rope either by a clip-pulley or by several wheels, round which the rope is taken, to obtain sufficient friction. The rope is kept constantly tight by having the return sheave fixed on a movable tram, to which a weight, hanging in a staple, is attached. The chief defect of this endless-rope system, as far as hitherto developed, is its inapplicability to the working of branches from the main-way, the tightness of the rope precluding the possibility of off-take links being used, as with the tail-rope. As this system is capable of conveying a large quantity of coals on a single way, the double way adopted at Shireoaks may be considered quite unnecessary, and can only be recommended where sockets are used, and runriders dispensed with, and where the inclination of the seam is such that one set of tubs will give assistance to another throughout the greater part of the plane. With regard to general economy, it is considered that this system of applying the endless-rope is scarcely sufficiently developed to justify an opinion being given as to its economy as compared with other systems. The duration of rope is about the same as with the tail-rope, the preference being rather in favour of the endless-rope system, which requires less rope. Not quite so much fuel is consumed as with the tail-rope, the power required being rather less, owing to the utilisation of the power lost in working with drums. With regard to the question of labour, the application of the system is so limited, as compared with the tail-rope and endless-chain, that it is only when a main-way without branches and stations is worked that the relative labour charges can be compared. There is a saving in the reduction of labour, consequent on the avoidance of drums and the labour of connecting the rope to the tubs.

The ENDLESS-ROPE SYSTEM (No. 2) is only in operation in the Wigan district, where it has not been many years in use. The principle on which the system is worked is the same as that of the endless-chain, wire-ropes being substituted for the chain, and the connection between the rope and the tubs being made by short chains instead of the fork arrangement. The application of this system at the Bridge Pit is much more extensive than at any of the other planes. The rope used is 1 in. in diameter, and passes two and-a-half times round the driving-wheels, the trod of which is shaped to receive it. It is made tight, to prevent it slipping on the driving pulley, by passing it round another sheave, a few yards from the end of the plane. This sheave is placed on a rolling-tram, which is attached by a screw to the vertical beam in the middle of the way; and the tightness of the rope is regulated by the screw, which, owing to the load upon the plane being nearly always the same, is better adapted for this system than the hanging weight, before referred to. With the exception of the item of labour, the cost of leading by this system is about the same as by the endless-chain, but the heavy cost of labour where there are branches from the main-way is sufficient to prohibit its adoption where branches are worked. There is, however, one condition of wagon-way to which this system might, perhaps, be more economically applied than any other—when a main-way without branches has a rise only in one direction, and has several curves, sharp or otherwise. The advantage of the endless-rope system for this description of plane over the tail-rope consists in its requiring less power, less labour, and in the construction of the curves being much less costly. The system might also be conveniently applied on a short plane, rising heavily in one direction, where a large quantity of coal has to be led.

The South Wales ENDLESS-CHAIN SYSTEM is only in operation at the Brynddu Colliery, where it is adopted as the most economical method of hauling the coals up a heavy gradient of 18 in. to the yard, this being the inclination of the seam of coal worked. Where the Lancashire endless-chain system—which can only be safely worked where the gradient does not exceed 12 in. to the yard—becomes inapplicable, the South Wales system may be adopted. But it can only be considered as more applicable when the plane to be worked is straight, has a regular inclination heavier than 12 in. to the yard, and has or has not any stations by the main-way; and when the plane to be worked has a regular inclination heavier than 8 in. to the yard, and has stations by the side of the mainway.

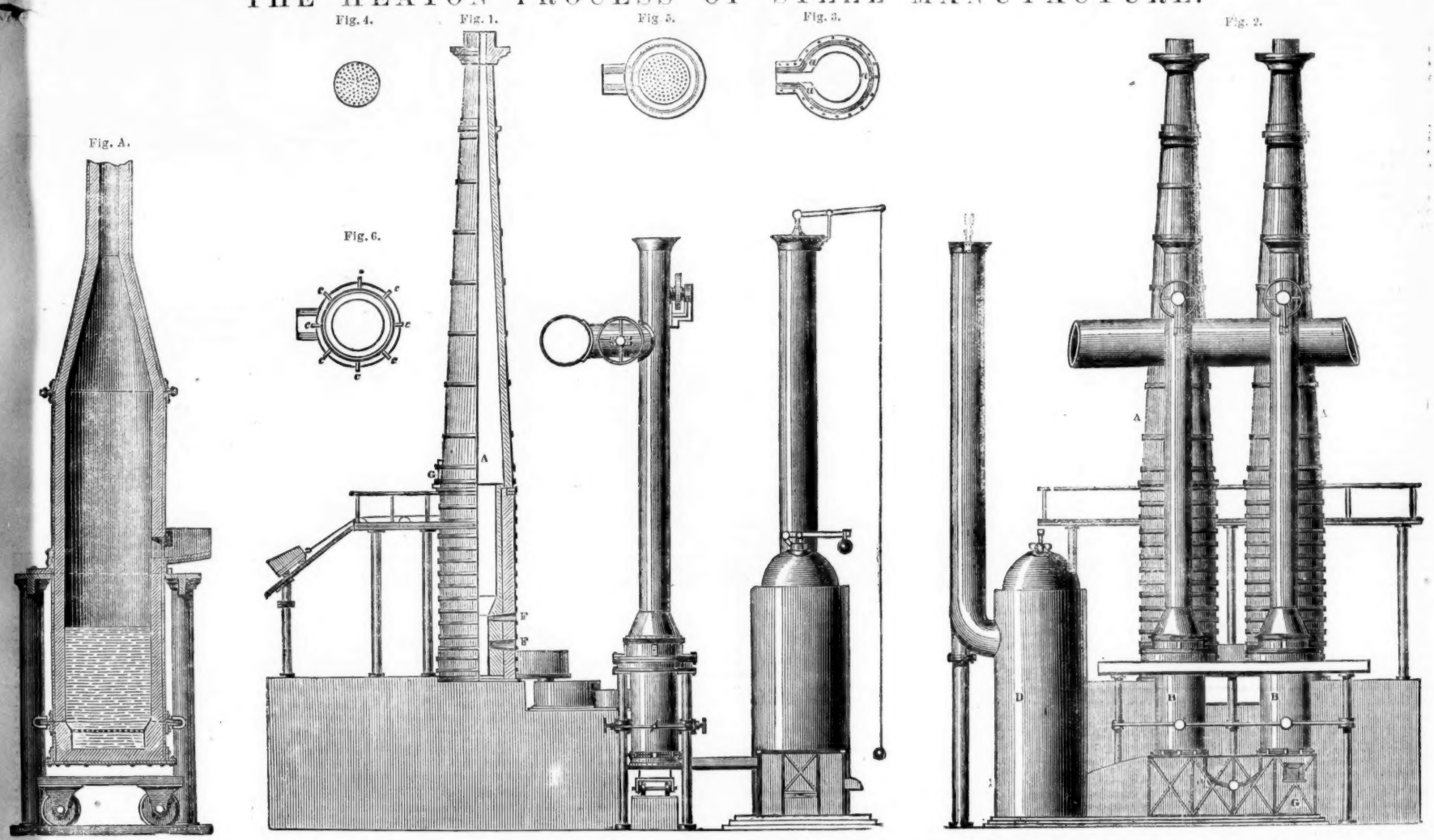
The systems of conveying coals reported upon are those which are

* "On the Haulage of Coal: being the Report of the Committee appointed by the North of England Institute of Mining Engineers to investigate the subject." Newcastle-on-Tyne: A. REID, Akenside Hill.

applicable to nearly every condition of wagon-way, and no data are given as to the economy of single-rope and self-acting planes. Where a system is peculiar to a district, as with the endless-chain at Burnley, and the No. 2 endless-rope at Wigan, it is used to work planes which have a rise either for full or for empty tubs; with the former condition the full tubs are hauled in the North of England by a single rope worked by an engine, whilst when the rise is for the empty tubs no engine is required—the full set of tubs drawing the empty set up the hill. When ropes are in use at any colliery for underground haulage, planes of this description are best worked with ropes, since the forks and double way necessary for the endless-chain are avoided; but if no system be established the endless-chain is preferable where the rise is against the load, whilst self-acting planes when regular are best worked by the single rope, and when irregular by the endless chain. Comparing the five systems reported upon, the Committee state that it appears, from the experience they have been able to obtain, that as far as the cost of maintenance and working expenses are concerned the endless-chain system can be applied, with few exceptions, to every condition of wagon-way with greater economy than any of the other systems, these exceptions being the cases—firstly, of the tail-rope system, where numerous branches are worked; secondly, of the No. 2 endless-rope system, where the plane rises in one direction, and has one or more sharp curves; and, thirdly, of the South Wales endless-chain system, where the gradient is heavier than 1 in 12, or than 1 in 8, where stations are worked. They are led to this conclusion by the fact that in each of the three chief items of working expenditure—economy of power, maintenances of ropes or chains, and cost of labour—the cost of the endless-chain is lower than that of any of the other systems. In the application of this system to curves underground, a man or boy will have to be placed at each curve,, but the extra cost caused by this will be more than repaid by the saving in the power exerted. The Committee also considers that the No. 1 endless-rope system is to be preferred to the tail-rope when the plane is undulating, has neither stations nor branches from the main-way, and is with or without slight curves; that the No. 2 endless-rope system is only to be economically applied under the conditions stated in the report, and that it cannot be advantageously adopted where the planes are undulating; and that the tail-rope system is preferable to the No. 1 and No. 2 endless-rope systems, whenever any stations by the side of the plane, or branches from the main-way, are to be worked.

The ability with which the Committee have performed the task they have undertaken is almost beyond praise, and but that every member is intimately acquainted with the practical details involved in the enquiry such valuable results could not have been obtained. They have not only carefully examined and ascertained the merits and defects of each of the systems of haulage reported upon, but have exerted themselves, although, unfortunately, without success, to obtain permission to examine another endless-rope system in use at Cinder Hill; and they have, moreover, expressed their willingness, should any question arise in the discussions which requires their further attention, to resume their labours. Their report, upon the printing and illustrating of which Mr. REID appears to have bestowed the utmost care, is one which will prove of lasting practical value; yet a very gratifying evidence of the economy with which such useful facts can be collected by gentlemen who really devote themselves to their task is afforded by the statement that "the expenditure to this date has not reached 75*l.*, which is the amount handed to the Committee by the treasurer on account of the grant of 100*l.*" More cannot be said in favour of the report than that it is calculated to give both the North of England Institute and the members of the Tail-rope Committee a permanent and favourable place in the memory of all connected with colliery operations.

THE HEATON PROCESS OF STEEL MANUFACTURE.



The value of sodium amalgam, in connection with the extraction of gold, has already been demonstrated, and from what has already appeared in the *Mining Journal* it will have been concluded that in the Heaton process of steel manufacture sodium is destined to play quite as important a part. The success of the Heaton process is to some extent connected with the pneumatic process, which is well known to have been one of the most remunerative ever introduced—that is to say, the effect is in a measure due to the action of the nitrogen. In Heaton's, as in the pneumatic, process there is a direct chemical action, but it is claimed to consist in the application to the molten crude iron of a far more powerful and searching agent than heated air. According to the Heaton process, pig or cast-iron, whatever be its quality, is melted in a common iron foundry cupola with coke fuel. The liquid iron in known mass—usually from a ton at a time to, perhaps, hereafter as much as 5 tons—is tapped out at present into an ordinary crane ladle, and the latter is swung round to the side of the converter. The converter consists of a tall cylinder of boiler plate, open at the bottom, which is supported at a certain height above the floor beneath it. This cylinder is lined with fire-brick, and above its upper part rises a cone and funnel of plate-iron, freely open at the top. To the bottom of the cylinder any number in succession of short nearly cylindrical pots, lined with brick and fire-clay, and in form very like crane ladles, are adjustable by simple means. Into the bottom of one of these pots a known weight of crude nitrate of soda of commerce is put; the surface of the gross powder is levelled and covered by a pretty thick circular plate of cast-iron, perforated with many holes, which lies by its own weight upon the top of the nitrate, but is held in its place by a projecting edge of the upper portion of the converter. One of these pots thus prepared having been adjusted to the bottom of the cylinder, the converter is now ready for ... At one side of the cylinder described is a sort of hopper funnel, covered by a loosely-hinged flap of boiler-plate. This plate is raised, and the ladle full of liquid cast-iron is at once poured into the converter, and so descends right down upon the top of the cold cast-iron perforated plate. The plate cannot float up nor become displaced, and no action becomes apparent for a minute or two, while the plate is rapidly acquiring heat from the fluid iron above it, and the nitrate getting heated by contact with it.

That the details of Mr. Heaton's invention may be more fully understood the above engravings are given, showing the plant as Mr. Heaton now recommends its construction, and as proposed for the steel plant of the company, to the formation of which reference was made in last week's Journal. The scale is one-eighth of an inch to a foot. Fig. 1 is a side view of the apparatus, showing also a vertical section of one-half of the cupola. Fig. 2 is a front view; and the same letters refer to the same parts in both views. Figs. 3, 4, 5, and 6 show different parts of the apparatus in plan. A A are cupola furnaces, in which the metal is melted. F F, in Fig. 1, are the tuyeres; G, the hole through which the cupola is charged with metal and coke from a platform with an inclined tramway leading to it. B B are the converters into which the melted metal is run direct from the cupolas, and from which the melted crude steel is run into a reverberatory furnace, C. D is a steam-boiler, heated with the waste heat from the reverberatory furnace. Fig. 3 is a horizontal section of the movable bottom of a converter, showing the fire-brick lining, *a a a*. When charged, the converter pot is filled with nitrate of soda. Fig. 4 shows a perforated metal plate, which is placed upon the nitrate of soda. Fig. 5 is a horizontal section of a converter, showing the perforated plate in position. Fig. 6 is a sectional plan of a converter, showing the cramps, *c c*, &c., for holding the converter pot up to the cylinder of the converter whilst the converting process is going on; these cramps are shown also in Figs. 1 and 2. The cost per ton for converting crude pig-iron into crude steel by this process, exclusive of the cost of the pig, but allowing for waste, is estimated to be 2*l.* 4s. per ton, or 2*l.* 15s. in crude steel cakes; the cost of making into steel-iron bars from the pig-iron is 3*l.* 10s. per ton of finished bars, and the cost of making into tilted cast-steel bars from the pig-iron is 12*l.* 15s. per ton.

With regard to the quality of the material, more important testimony than that of Mr. R. Mallet, F.R.S., whose reputation as an authority upon such matters is well known, cannot be adduced. He reports that Dr. Miller has proved incontrovertibly that the Heaton process does eliminate from the crude pig-iron almost the whole of the phosphorus and sulphur, the trace remaining being unobjectionable in the wrought-iron and steel produced, even when these have been made from the pig-irons known to be the richest in these injurious constituents of any make in Great Britain. The wrought-iron made in his presence, from Cleveland and Northampton pigs, and tested for tensile resistance also before him, bore a rupturing strain of 23 tons per square inch, and an elongation of nearly one-fourth of the original unit in length. It is, therefore, iron of great strength and toughness, and yet probably by no means the very best that this process is capable of producing hereafter. It possesses those qualities which best fit iron for artillery, armour-plates, and iron ships or boilers. The tilted cast-steel, also made in his presence, from the very same pig-irons as the above, bore a tensile strain at rupture of above 42 tons per square inch, with an elongation exceeding one-twelfth of the unit of length. It is, therefore, a remarkably tough and fine quality of steel, well suited for rails, shipbuilding, and all other structural uses. In a word, steel suited for any purpose known to the arts can be produced by this system from very inferior brands of pig-iron—from such as by no other known process could serviceable steel be made at all.

The economy of the process is described as beyond question, since it competes with every other at an advantage of several pounds sterling per ton. It deals with the cheapest and most impure as well as with the best raw material. It produces steel direct from pig-iron. Whereas the plant necessary for the production of steel and wrought-iron by other processes is enormously expensive, steel can be produced by Heaton's patented process at an exceedingly low cost, and at an insignificant outlay of capital. The cost of the necessary plant, including patent converting apparatus, capable of producing, from a series of four converters, 80 tons of crude steel per 12 hours, does not exceed 1000*l.* The cost of maintenance of the plant is altogether insignificant. The waste of metal in conversion is reduced greatly below that of any other known process; the slag produced is already utilised in the works. The process being chemical and not mechanical, the labour and expenditure consequent on the carrying out of the puddling process are entirely dispensed with. The process of conversion is simple, rapid, and certain, a few minutes sufficing to produce the results. And, lastly, it is claimed that the results obtained are remarkable for their uniformity. The Heaton process supersedes the puddling process, and does *not* exact the absence of sulphur and phosphorus, and makes good steel and iron from pig containing either or both of these impurities in large proportions.

The part which sulphur and phosphorus play in connection with the Heaton process is, perhaps, the most remarkable point in connection with it, for one way or other it appears to prove that at present nothing is accurately known by metallurgists generally either as to the metallurgy of iron, or as to the constituents which possess a deleterious influence upon its quality. Dr. Miller reports that "the quantity of phosphorus (0·298 per cent.) retained by the sample of crude steel from the converter which he analysed is obviously not such as to injure the quality," and this opinion was confirmed by a sample from the same bar bearing a tensile strain of 23 tons in Kirkaldy's testing machine. So high a percentage has hitherto been considered sufficient to render the iron or steel containing it comparatively worthless, and hence an effort has been made to ascertain what element neutralises the prejudicial effect in the particular sample experimented upon. Dr. Paul seems to attribute it to the presence of calcium in a larger quantity than usual, but whether this is the true explanation of the peculiarity has yet to be proved. But, however that may be, it appears that there is no difficulty, at a cost of a few shillings per ton—if the iron is run direct from the blast-furnace into the receiver—of evolving the required gases for freeing the metal from silica, sulphur, and the greater part, if not the whole, of the phosphorus, and which iron so refined can be made equal to the several qualities of spiegeleisen and best Swedish brands; and, when melted in Siemens's furnace with certain proportions of wrought-iron, can be run out into homogeneous metal suitable for rolling into steel rails, or the iron, when so refined, can be converted into steel by nitrates or other chemicals equally as efficient, and at a less cost than even Mr. Heaton lays it at.

Heaton's apparatus is in principle equally applicable to all chemicals whose specific gravity being less than that of molten metal requires their retention below its surface till decomposition is effected. It is positively asserted by gentlemen conversant with the nitrate deposits of South Peru that the present excessive price is exclusively due to the difficulties and cost of transport to the port of shipment, to which it is conveyed on the backs of mules, who have also to carry their own water, through an inhospitable region, for some 30 miles. A rail or tram long since projected would reduce the cost by more than one-half, and there is reason to believe that it could be delivered in England, with ample margin for profit, in any quantity, at some 7*l.* per ton. Therefore, it is probable that Mr. Heaton's estimate of cost is excessive.

IMPROVEMENTS IN WATER-WHEELS.—According to the invention of Mr. J. P. Collins, of Troy, U.S., it is proposed to enamel all portions of any water-wheel exposed to the action or force of the water with some suitable material, or combination of materials, thereby giving a smooth and glazed surface, over which the water flows with greatly diminished friction, of course adding proportionally to the efficiency of the wheel. It is obvious, also, that all chemical action of the water must be entirely prevented by such a coating. The patent upon this improvement does not limit the inventor to any particular silicious substance or combination of substances, and he is at liberty to use any materials for the purpose above described that he may find upon experiment to be useful. The invention is also applicable to the prevention of the oxidation of iron wheels generally.

CONSUMPTION OF COAL ON RAILWAYS.—One of the innovations of the past year has been the adoption, to a limited extent, of Hirwain coal instead of coke as a fuel on the Metropolitan Underground Railway. This was, perhaps, the only line in the kingdom regularly using coke as fuel, and so vividly presenting us with the days long gone by. When coke ceases to be used there, coal will remain supreme over the locomotive world. The Hirwain coal is very peculiar, and we shall have more to say about it. It is particularly free from sulphur and offensive fumes, and its use has cleared the Metropolitan tunnels, and done good. On the North London Railway it is freely used, with excellent results. Steam can be kept with it with closed ash-pan doors, and the brick is not required to prevent smoke. In a recent experiment an engine was kept under steam during two runs of 48 minutes duration each, with an average passenger train, and in all this time the fire was never touched, nor was an ounce of fresh fuel added to what was in the fire-box at starting. This speaks highly of the character of the coal.—*Engineer.*

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IMPROVED STONE-DRESSING MACHINERY.

There is probably nothing which has added more to the beauty and imposing effect of the great buildings, public and commercial, erected in London and other large cities, than the extensive introduction of polished granites, serpentines, and similar hard stones for the purposes of ornamentation, and it is gratifying to find that this class of decoration continues to come more and more into favour. It cannot, however, be denied that the heavy cost of dressing such stones has hitherto acted as a powerful preventive to their introduction; for, where the funds at disposal were limited, a more easily-fashioned material was usually employed. An improved machine, from the designs of Mr. Joseph E. Holmes, of Chester, is now being manufactured by Mr. B. Johnson, of that city, and by Messrs. Ormerod, Grierson, and Co., of Manchester, which appears to have given complete satisfaction wherever it has been introduced. The general character of the machine and its mode of operation will be readily understood from annexed engravings, where A A is the main framing, which comprises the bed-plate, A', on which the block of stone to be cut is fixed. B B are travelling arms, in which the cutter-stock or cross-head (fitted with chisels, picks, and tools) is mounted, and which arms and cutters are made to traverse the main frame, A A, from end to end alternately, or from left to right, and *vice versa*, by the screws, *c c*; *d d* are eccentric bearings, or plummer-blocks, in which the ends or journals of the cutter-stock or cross-head are centred. These bearings may be turned by a lever or levers, not shown in the engravings, and may be fixed in position by stop-bolts; *e* is the cutter-stock or cross-head, in which the picks, chisels, and tools are fixed. The picks or chisels are shown at *e e*. A lever, F, is fixed to the stock or cross-head for giving right and left hand cutting motions to the chisels or tools, as the case may be, this lever being coupled by the connecting-rod, I, to the crank of a cranked-shaft, G, centred in the centre of the travelling arms, B B, and turned by the mitre-wheel, H. By taking out the pin, *g*, the connecting-rod, I, can be readily uncoupled, and the lever, F, turned so that it inclines in the opposite direction, for the purpose which we shall explain presently. J is the main shaft, having a driving-pulley, K, keyed on it at one end, and a slotted crank, L, also keyed at the other end. M is a second mitre-wheel, mounted upon a short hollow shaft, *m*, which turns in a bearing provided on the head of one of the travelling arms, B. The main shaft, J, has a long groove cut in it to receive a tongue, or feather, in the hollow of the shaft, *m*, which is thus turned by, and traverses on, the main shaft from end to end, as the arms, B B, are moved backwards and forwards by the screws, C C. The heads of the arms, B B, are connected by the tie, or parallel bar, *h*. Bevel wheels, N, are keyed on to the ends of the screws, C C, and are connected by a shaft carrying other bevel wheels, as shown. O is a ratchet wheel, fixed on the upper screw shaft at the opposite end to the bevel wheel, N; whilst P, a lever centred upon the ratchet wheel, O, and fitted with a double or reversing pawl, adjustable for turning the screws, C C, from left to right, or *vice versa*, according to the direction in which it is desired to work the cutter. A connecting-rod, or link, Q, gives a rocking motion to the lever, P, by the revolutions of the slotted crank, L, on the end of the main shaft. The crank-pin of this crank works in a hollow screw clamp, and by varying the position of the crank-pin the lever, P, can be made to turn the screws, C C, more or less at each revolution of the main shaft, J, and thus regulate the feed. R, S, and T are the clamps, screws, and cross bars by which the stone is secured in position while being dressed.

In practice, the stone to be dressed is placed upon the bed-plate of the machine, with the side to be operated upon towards the cutters, and it is then fixed in position by the clamps and screws. The cutters having been previously moved to one end of the machine, and the cutter-head set to the required angle, the power is applied through the pulley to the main shaft, whereby the whole of the moving part of the machine will be set in motion. If the block be tolerably quarry-faced, the surface operated upon will be cut nearly true by the narrow chisels at one traverse of the cutter-arms, and then by reversing the cutter-stock, so as to bring the broad chisels into play, the stone will be evenly tooled and finished on the back journey of the cutter-arms; by turning the block, the beds, faces, and joints may be dressed with truth and rapidity. By inclining the bed-plate or table more or less, any required angle may be given to the surfaces. Hence, when the machine is once set, the work produced by it upon any number of blocks will be perfectly uniform, causing their beds and faces, or the angle of their surfaces to each other, to be perfectly true one with another. Thus, the use of square bevels and templates, &c., and the loss of time for setting out and working marginal drafts, as when dressed by hand labour, may be avoided. Where the stone requires a second or third rough chiselling before applying the broad tools, either the cutter-stocks can be made reversible, or the tools may be turned to clear the face, and the chisels run back. The machines can be made of almost any size, but Mr. Holmes considers it most convenient for ordinary purposes to make the cutter-stock give a cut 3 ft. wide, with a traverse motion of 8 ft., or so as to dress the surfaces of a block of any size up to 7 ft. in length by 3 ft. in width. For convenience of locomotion, the main frame may be provided with wheels, and, when necessary, a swing or travelling crane may be added to facilitate the operations of moving and turning the blocks of stone to and from and upon the bed-plate. It is claimed that from the manner in which the tools act upon the stone, the motion is very similar to that given to them by hand labour.

With a view to enable those interested to judge of the value of the invention, Mr. Holmes has one of the machines at work at the old Salisbury Wharfs, Strand, and its action upon very hard stone certainly appears most satisfactory; it has been found that such machines are capable of dressing the hardest sandstones or millstone grits with an average forward cut of 18 in. per minute. With stones fairly quarried or scabbled, not more than two cuts are required for the beds and joints, a third cut being taken for finished face-work. With stones 3 ft. deep, a rate of advance of 18 in. per minute gives 4½ square feet dressed per minute, apart from the time occupied in turning and fixing the stones, so that one machine will work from 200 to 300 superficial feet per day. The excellent quality of the work is beyond question, and the value of the machine is much enhanced by the fact of its being capable of tongueing and grooving the entire surface of the beds and joints of the stones without additional cost. The machine is well worthy of thorough examination.

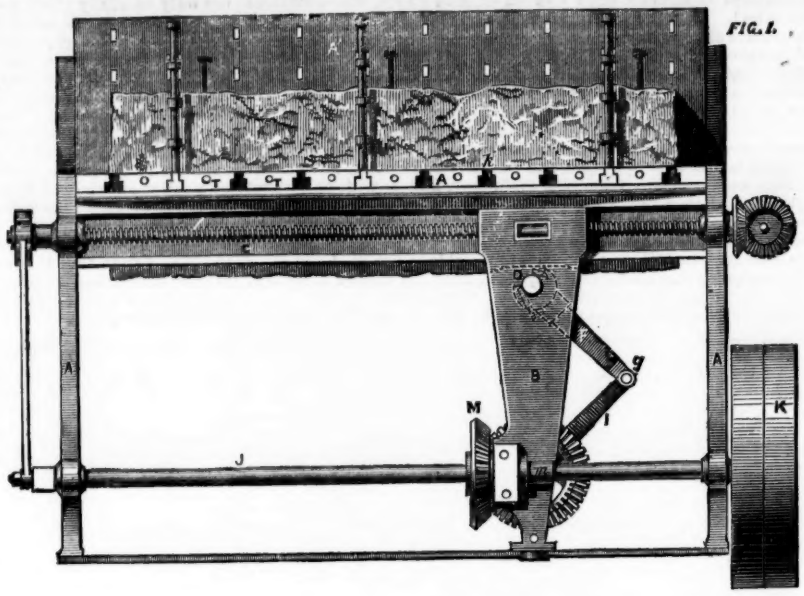

FIG. 1.

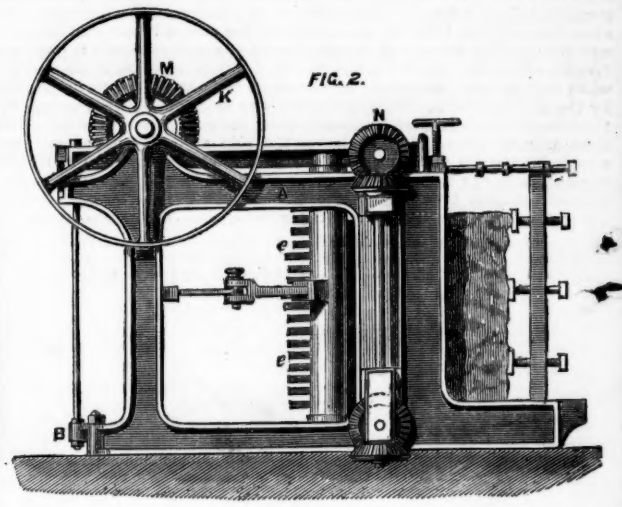

FIG. 2.

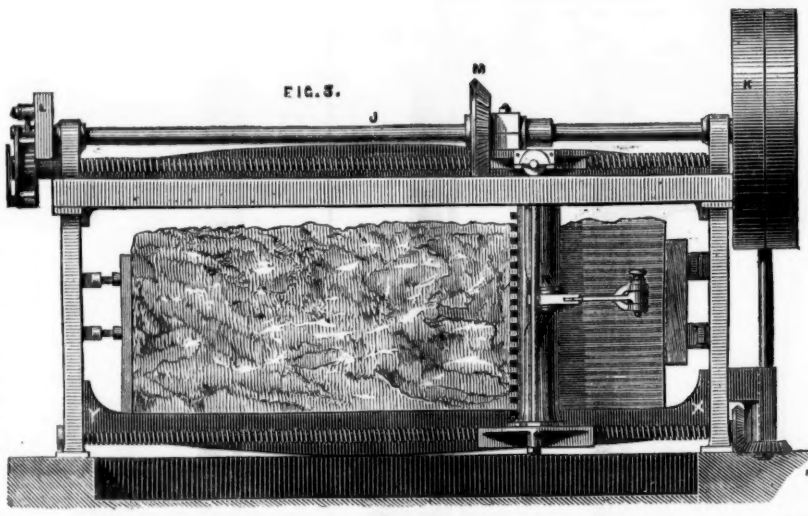

FIG. 3.

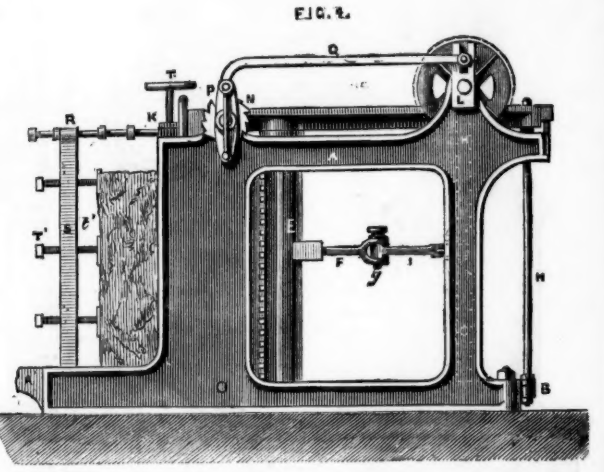

FIG. 4.

THE MANUFACTURE OF WATCHES AND CLOCKS.—A most interesting and instructive little work, describing briefly, but with great clearness, the rise and progress of watch and clock making, has just been published by Mr. J. W. Benson, of 25, Old Bond-street, 99, Westbourne-grove, and the City Steam Factory, 58 and 60, Ludgate-hill. The book, which is profusely illustrated, gives a full description of the various kinds of watches and clocks, with their prices, and no one should make a purchase without visiting the above establishments or consulting this truly valuable work. By its aid persons residing in any part of the United Kingdom, India, or the Colonies, are enabled to select for themselves the watch best adapted for their use, and have it sent to them with perfect safety. Mr. Benson, who holds the appointment to the Prince of Wales, sends this pamphlet to any address on receipt of two postage stamps, and we cannot too strongly recommend it to the notice of the intending purchaser.

FOREIGN MINING AND METALLURGY.

The Liége coal market shows weakness. The continued mildness of the winter is not favourable to the development of a large business, but, nevertheless, the prospects before the Belgian coal trade are not bad, by reason of the considerable orders which have been received by the metallurgical establishments. Freights show little or no variations, and the same may be said with regard to prices. There has been a strike at the Flénu Produits Colliery, but it has been of no great importance. The anticipated re-adjudication of rails on account of the Belgian State Railways has now taken place; a modification appears to have been made in the *cahier des charges*, the guarantee period being reduced from five to three years. The ten lots contracted for were let to MM. de Dorlodot, and others, at 7*l.* 1s. 10d. to 7*l.* 3s. 7d. At the first adjudication attempted the tenders ranged between 7*l.* 16s. 3d. to 7*l.* 19s. 11d. per ton, so that the re-adjudication resulted in a saving to the Government of about 16s. per ton, the only advantage gained by the contractors being the reduction of the period of guarantee from five to three years. The re-adjudication now made will probably be carried out, and in future it is not expected guarantees of five years will be required in connection with the rails supplied to the State railways. In all, as has been already stated, ten lots of rails were let; the first, third, fifth, eighth, and tenth lots were let to MM. de Dorlodot, the second to M. Blondieaux, the fourth to the Châtelineau Company, the sixth to the Montigny Company, the seventh to the Monceau Company, and the ninth to the Marcinelle and Couillet Company. In the first tendering nine houses instead of six were represented; the Cockerill and Sclessin Works did not take part in second adjudication. For the old rails put in adjudication at the second biddings higher terms were proposed than on the first occasion, 4*l.* 12s. and 4*l.* 9s. 6d., instead of 4*l.* 10s. and 4*l.* 6d. per ton offered on the first occasion. A fresh advance is noted in the price of refining pig in Belgium, transactions not being concluded at less than 3*l.* per ton in the Charleroi basin, notwithstanding heavy arrivals of similar pig; a slight stock remains to be run off. The intelligence received from Liége is favourable, but especially so as regards rails. No. 2 casting pig is quoted at Charleroi at 3*l.* 2s.; ditto, No. 4, at 3*l.* 4s.; ditto, No. 3, at 3*l.* 6s.; ditto, No. 2, at 3*l.* 8s.; ditto, No. 1, at 3*l.* 10s. per ton. Fine-grained pig is quoted at 3*l.* 4s. per ton, and refining pig for bars and plates 2*l.* 18s. per ton. Iron in bars is quoted at 6*l.* 4s. per ton for No. 1, 6*l.* 16s. per ton for No. 2, 7*l.* 8s. per ton for No. 3, and 8*l.* 4s. per ton for No. 4. Common plates are quoted at 8*l.* 8s., boiler-plates at 9*l.* 4s., and extra plates at 12*l.* 8s. per ton. Several contracts for rails have been negociated; the delivery will extend into 1870. The Northern Railway Company has brought into operation two tariffs at reduced rates, one for minerals forwarded from the valley of the Meuse to the Charleroi basin; and the other for various heavy goods—and among the rest combustible—forwarded from the Liége-Seraing basin to the line from Namur to Givet, and *vice versa*. It appears that reductions are also to be accorded as regards the present rates charged for the conveyance of coal towards the East of France, *via* Givet. Meetings are announced as follows:—Piéton-Campagne Colliery Company, Feb. 15, at Charleroi; Trieu Kaisin Colliery Company, Feb. 16, at Châtelineau; and Quaregnon United Collieries Company, Feb. 28, at Quaregnon.

The French iron trade presents no material change, but the improvement which has been taking place of late has now become general. An official announcement of an advance of 8s. per ton on all the products of Creusot has occasioned a legitimate satisfaction in all the siderurgical districts of France. The Hayange Works have also advanced their prices 8s. per ton on the Paris market. An adjudication for *matériel* is to take place on Feb. 17 at the prefecture of the Ardennes. The adjudication will comprise 3500 tons of Vignoles rails, 32,000 bolts, 17,500 fish-joints, &c. The Roujan Collieries Company has decided on the creation of 10,000 new shares of 2*l.* each; 2000 of these shares will be issued immediately, and will be reserved to the holders of the old shares,—at any rate, in the first instance.

The state of the Prussian metallurgical markets continues good, orders having arrived in abundance at the works. The improvement in the iron trade of Prussia is reflected in the favour now enjoyed on the Berlin bourse by the shares of mining, blast-furnaces, and forge com panies. The advance in the shares of some of these companies has been rather considerable. The requirements of Prussian railways for the current year are likely to be important; lines projected, as well as those which are about to be extended, will require great quantities of rails and other materials. For instance, the Administration of the Upper Silesian Railway is having manufactured 2850 tons of iron rails and 6140 tons of cast-steel rails, and a great quantity of bolts, fish-plates, &c. The Royal Direction of the Hanoverian Railways is having manufactured 290 tons of cast-steel rails, 74,260 pieces of puddled steel fish-plates, &c. The Royal Direction of the Guillaume Railway (Ratibor) is having manufactured 150 tons of cast-steel rails, 1080 tons of iron rails, &c. The Administration of the Thuringian Railway is having manufactured 662 tons of rails, 45,000 bolts, 14,000 pieces of fish-plates, &c. The Administration of the Breslau, Schweidnitz, and Fribourg Railway is having manufactured 2000 tons of rails. The Administration of the Right Bank of the Oder Railway is having manufactured 500 tons of iron rails and 10 tons of puddled steel rails. The Administration of the Bergisch and Markisch Railway is having manufactured 11,500 tons of puddled steel rails, 100 tons of rails of fine iron, 650 tons of fish-plates, 41 passenger carriages, 40 baggage vans, 500 open goods trucks, &c.

A rather marked fall has occurred in copper at Havre, Chilian in bars having receded to 74*l.* per ton; there has since been a slight revival, and at the last dates this description stood at 74*l.* 16s. per ton, but without, however, much business being done; 75*l.* 8s. had been paid for one lot of 25 tons, to be delivered at the end of February. The transactions of January at Havre comprised 1650 tons of disposable, at 74*l.* to 76*l.* 12s. per ton; 510 tons to be delivered from Feb. 15 to the end of March, at 74*l.* to 77*l.* per ton; and, finally, 36 tons of Urmeneta of a low standard sold at the commencement of January, at 70*l.* 10s. per ton, making a total of 2196 tons of bars, plus 70 tons of ingots, at 76*l.* 4s. to 80*l.* per ton. At Paris, as well as at Havre, quotations have been feeble, and the article has been in little demand; prices range from 74*l.* 8s. to 74*l.* 16s. and 75*l.* per ton. At Marseilles the downward movement remarked on the other markets has made itself felt to a less extent, and prices remain about the same as before. The German markets are stationary; at Hamburg quotations have been well sustained, in consequence of the scantiness of stocks. The quantity of tin imported at Havre in January was 4962 tons; prices remain at this centre without much variation, Banca making 114*l.* to 117*l.*, and Straits 112*l.* to 116*l.* per ton. The price of Banca has remained about the same at Berlin; at Stettin, also, there has been but little variation. The Dutch markets have displayed rather less activity. At Amsterdam sellers have maintained a quotation of 67½ fls. for Banca, but at this price few transactions have taken place. The quantity of lead imported at Havre in January amounted to 10,925 saumons. English lead has been dealt in at Havre at 19*l.* 4s. to 19*l.* 6s. per ton; and soft Spanish, first fusion, at 19*l.* 4s. per ton. The price of lead has been maintained without material change at Paris; the same may be said of Marseilles. At Hamburg, the lead market has displayed rather a firmer tendency. The importations of zinc at Havre in January amounted to 1326 tons; some transactions have taken place at 20*l.* 8s. to 20*l.* 16s. per ton. At Paris prices have been well maintained; Silesian has made 22*l.*, and other good marks 21*l.* 12s. per ton. At Hamburg there has been increased firmness and activity; in three days 900 tons changed hands.

A NEW AND CHEAP MODE OF EXTRACTING GOLD FROM QUARTZ.—The present excitement with respect to the finding of gold amongst the primitive formations of Scotland will probably subside into a state of hopeless inactivity as soon as it has become more generally known that in the Scotch rocks the gold exists only in a highly diffused form, by which its extraction is rendered so costly that no method hitherto employed can be advantageously put into operation on a large scale for the working of gold ore in Scotland. At the same time, the quantity of rock containing gold in Scotland appears to be large beyond the range of even enthusiastic belief; and, indeed, it is almost a question of doubt whether any large masses of the rock called "opaque quartz" can be found in Scotland which do not contain some portion of gold. More than six years ago gold was extracted from some specimens of opaque quartz found near Inverary, in Argyleshire, and it is a curious fact that much of the gold obtained in California was discovered in opaque quartz similar to that of Scotland. The great hardness, however, of this rock not only renders it difficult to work, in the first instance, but also causes so much expense during its reduction to the condition of a fine powder, in which state alone the gold can be got from it by amalgamation, that none but the richest quartz can be profitably worked. Nevertheless, as a very large portion of all the mountains situated between Inverary and Loch Awe on the west, and Cromarty on the east, contain opaque quartz of the above kind, the importance of a cheap and practicable mode of working this rock needs no comment. Looking at the present rage for that kind of monopoly called "patent right," it may seem incredible that any person can be found willing to give up a valuable process to the public at large. Those, however, who have had any experience in patents will easily understand the motives which induce me to publish the following method of separating in a profitable manner the most minute portions of gold from quartz, granite, or other rock:—First, let the rock be roasted at a red-heat, as is practised with regard to flints intended for pottery ware. This roasting renders it easy to break the rock afterwards by a hammer into pieces about the size of small apples. In this state the rock must be placed in a large earthenware tube previously fixed in a furnace, so that the tube passes horizontally through the furnace, and leaves its two ends open to the air. The kind of tube here indicated may easily be understood by supposing a common earthenware gas retort open at both ends and set in a furnace, as is done in gas making, but with both ends projecting from the furnace. The heat in the interior of this tube must be what is called a bright cherry-red, or incipient white heat. If under these conditions we now pass through a tube a current of chlorine gas, either pure or mixed with atmospheric air, as in the making of chloride of lime, then the chlorine will combine with and volatilise the whole of the gold existing in the broken rock, and this gold will be carried no further out of the other or open end of the tube than to the part which is at a dull red heat. At this point the whole of the gold will be deposited, for it is a singular fact that although at a white heat, chlorine gas combines with gold and renders it volatile, yet by cooling to a dull red heat the two substances separate and the gold is deposited. And when other metals are present this separation is promoted by passing coal gas into the tube. I do not consider it necessary to dwell upon the methods needed for the subsequent collection of the gold, for these must necessarily vary according as the rock contains silver, iron, or other metal. The object in view is to develope a cheap and easy mode of separating gold from primitive rocks, without incurring either the labour of pulverisation or the expense of amalgamation.—T.: *Newcastle Daily Chronicle.*

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London: Printed by RICHARD MIDDLETON, and published by HENRY ENGLISH (the proprietors), at their offices, 26, FLEET STREET, E.C., where all communications are requested to be addressed.—*Feb.* 13, 1869.